PERFORMANCE OF BLUE LUPIN (*LUPINUS ANGUSTIFOLIUS* L.) CULTIVARS ON A PSEUDOGLEY SOIL IN SERBIA

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ABSTRACT

The goal of modern blue lupin (*Lupinus angustifolius* L.) breeding programs, such as the one that is carried out in the Saatzucht Steinach GmbH in Bornhof, Germany, is the improvement of tolerance to abiotic and biotic stress and certain morphological and physiological changes. Blue lupin is almost unknown in Serbia, but a recently launched breeding program on white (*Lupinus albus* L.) and blue lupins in the Institute of Field and Vegetable Crops in Novi Sad provided encouraging results on the introduction of these two species in the country. A small-plot trial was carried out on a pseudogley soil, with a pH value of 4.79, at the Experiment Field of the Dr Đorđe Radić Secondary School of Agriculture in Kraljevo during 2006 and 2007. In comparison with all other cultivars, the cultivar Bolivio produced higher grain yield (2311 kg ha^{1}), while the lowest grain yield was in the cultivar Boregine (1525 kg ha^{-1}). The annual grain yield in these six examined blue lupin cultivars ranged from 1425 kg ha^{-1}, in the cultivar Boruta in 2006, to, 3005 kg ha^{-1}, in the cultivar Bolivio in 2006.

KEYWORDS

Lupinus angustifolius, grain yield, grain yield components, pseudogley soil

INTRODUCTION

Blue or narrow-leafed lupin (*Lupinus angustifolius* L.) is one of the economically most important grain legume species in many regions of the world (Angelova and Kitcheva, 2002). Blue lupin was used as a forage crop and green manure in ancient times (Hondelmann, 1984), while its cultivation as a grain legume is more recent. One of the greatest achievements of modern breeding research is the development of the cultivars with low alkaloid content, often called sweet lupins, that became widely distributed in the countries such as Australia, South Africa, Chile and Poland (Cowling *et al*. 1998).

Contemporary breeding programs on blue lupin, such as the one that is carried out in the Saatzucht Steinach GmbH in Bornhof, Germany, are aimed not only at increasing grain yield, but at the improvement of tolerance to abiotic and biotic stress, with the incorporation of certain morphological and physiological changes. One of the strategic goals of such programs is the improvement of tolerance to high pH values of diverse soil types (Eckardt *et al*. 2004). This has an essential significance for increasing the growing area of this species, since blue lupin, in a rather similar way to other lupin species (White and Robson, 1989; Duthion, 1992), is regarded as not tolerant to alkaline soils with high pH values of more than 7.4 and large amounts of calcium, mainly due to lack of micronutrient availability and especially iron (Eickmeyer *et al*. 2004).

Blue lupin is almost completely unknown in Serbia (Mišković, 1986), with no official data on its growing area or production. On the other hand, a recently established breeding program on white and blue lupins in the Institute of Field and Vegetable Crops in Novi Sad obtained good preliminary results on the introduction of these two species in the country, with a significant progress in testing white lupin on chernozem soils in the northern Serbian Province of Vojvodina (Mihailović *et al.* 2007).

The main goal of the study was to assess the possibility of growing blue lupin on acid soils in Serbia, as well as to determine the potential of advanced blue lupin cultivars for grain yield when cultivated in such conditions.

IN J.A. Palta and J.B. Berger (eds). 2008. 'Lupins for Health and Wealth' Proceedings of the 12th International Lupin Conference, 14-18 Sept. 2008, Fremantle, Western Australia. International Lupin Association, Canterbury, New Zealand. ISBN 0-86476-153-8.

MATERIALS AND METHODS

A small-plot trial was carried out in 2006 and 2007 at the Experiment Field of the Dr Đorđe Radić Secondary School of Agriculture in Kraljevo, including six blue lupin cultivars developed in the Saatzucht Steinach GmbH, namely Boruta, Boltensia, Boregine, Bora, Borlu and Bolivio.

All six cultivars were sown by hand on 21 April in the first year and on 2 April in the second year, with a plot size of 5 m^2 and at a crop density of about 100 viable seeds m^{-2} (Vučković, 1999). Each cultivar was harvested in the stage of full maturity of grains of the first pods, which was on 26 July in the first year and on 10 July in the second year. The main prevailing climatic conditions in both years are given in the Table 1, while the chemical analysis of a pseudogley soil in Kraljevo is given in the Table 2.

The following data was recorded: grain yield per area unit (kg ha^{-1}), plant height (cm), and grain yield components, including number of pods ($plant^{-1}$), number of grains ($plant^{-1}$) and thousand grains mass (g). The analysis of plant height, number of pods, number of grains and thousand grains mass was based upon the samples taken immediately before harvest. Grain yield per area unit was calculated on the basis of grain yield per plot and at the moisture level of 14%.

The results of the study were processed by analysis of variance (ANOVA), with the Least Significant Difference (LSD) test applied, and using the computer software MSTAT-C.

RESULTS AND DISCUSSION

The two years differed in the sowing dates mostly due to a late and wet winter in 2006. It caused a slow drainage of a heavy and hydromorphic soil type such as pseudogley and a rather late sowing by the end of April. In general, the first year was characterised by a very rainy June, the month in which the blue lupin cultivars pass from the stage of flowering into the stage of pod formation and maturing: such conditions were more favourable for the cultivars with a longer growing period, such as Bolivio. On the other hand, the second year had more desirable characteristics, such as earlier sowing date, more rain in May, when all cultivars were in full flower, and higher temperatures and less precipitations in June and July, when all six cultivars were in the stage of maturing.

There were significant genotypic differences ($P < 0.05$-0.01) for all characters (Table 3). Bolivio, Borlu and Boltensia were all tall cultivars with large numbers of pods per plant (Table 3). Bolivio produced significantly more seeds per plant than the other 2, reflecting its relatively smaller seed size (Table 3). Boregine was consistently low yielding in both years, Bolivio ranked 1st in 2006 and 3rd in 2007 (Table 4), whereas in the remaining cultivars the 2007 yield was negatively correlated to 2006: $r = -0.95$ without Bolivio and Boregine and $r = -0.66$ without Bolivio (Graph 1).

CONCLUSIONS

The six blue lupin cultivars have shown promising two-year results of grain production on acid soils, dominant in many of the central parts of Serbia. The future research on blue lupin will be aimed at a more detailed study of its grain yield components, the improvement of its agronomy and the possibility of its utilisation as forage or green manure crop, as well as to the testing of promising genotypes in diverse locations.

ACKNOWLEDGEMENTS

The research is a part of the Project 20083 of the Ministry of Science and Technological Development of the Republic of Serbia (2008-2010).

The paper is dedicated to the memory of late Raymond Jones of the Institute of Grassland and Environmental Research (IGER) in Aberystwyth, Cymru (Wales), UK.

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Table 1. The average monthly temperatures and precipitation sums during the growing period of lentil in 2006 and 2007 in Kraljevo.

Average monthly temperature (°C)					
Year/Month	April	May	June	July	Average
2006	13	16	20	22	18
2007	12	18	22	24	19
Monthly precipitation sum (mm)					
Year/Month	April	May	June	July	Sum
2006	81	33	132	24	270
2007	16	128	28	20	192

Table 2. Agrochemical analysis of the pseudogley soil in Kraljevo during 2006 and 2007.

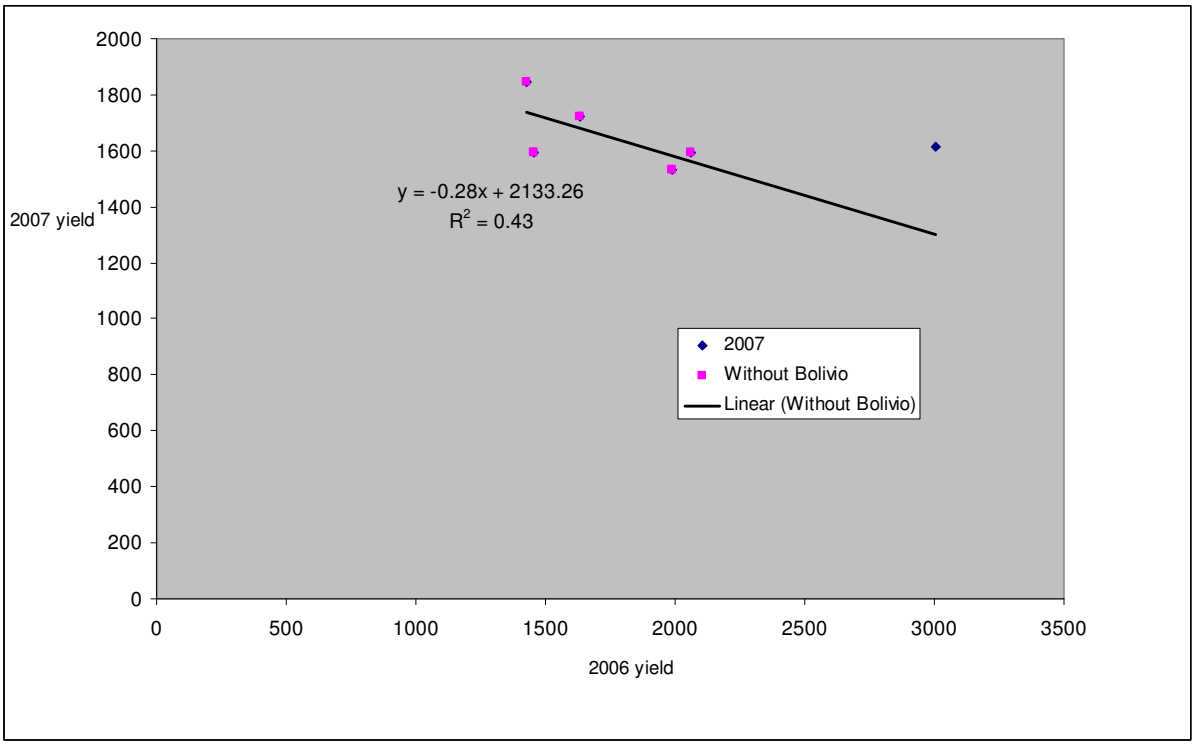
pH (H_2O)	N (%)	P_2O_5 (mg 100^{-1} g^{-1})	K_2O (mg 100^{-1} g^{-1})	$CaCO_3$ (%)	Humus (%)
4,79	0,13	7,20	11,00	0,00	2,56

Table 3. Average values of grain yield components of blue lupin cultivars in Kraljevo for 2006 and 2007.

Cultivar	Plant height (cm)	Number of pods ($plant^{-1}$)	Number of grains ($plant^{-1}$)	Thousand grains mass (g)
Boruta	46	3.7	13.3	155
Boltensia	57	5.0	14.0	191
Boregine	49	4.8	11.5	139
Bora	49	4.5	13.3	154
Borlu	52	5.2	13.5	177
Bolivio	54	6.8	20.7	153
$LSD_{0.05}$	5	1.6	4.5	51
$LSD_{0.01}$	8	2.1	6.2	74

Table 4. Grain yield (kg ha-1) of blue lupin cultivars in Kraljevo for 2006 and 2007.

Cultivar	Year		
	2006	2007	Average 2006-2007
Boruta	1425	1845	1635
Boltensia	1634	1720	1677
Boregine	1457	1592	1525
Bora	2062	1596	1829
Borlu	1989	1533	1761
Bolivio	3005	1616	2311
$LSD_{0.05}$	996	207	508
$LSD_{0.01}$	1376	264	698



Graph 1. Correlation between annual grain yields of blue lupin cultivars in Kraljevo in 2006 and 2007.